

Silicon Germanium Cryogenic Power Heterojunction Bipolar Transistors

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TECHNOLOGY

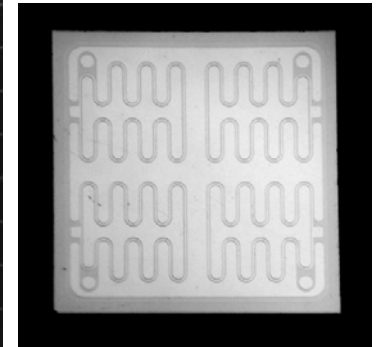
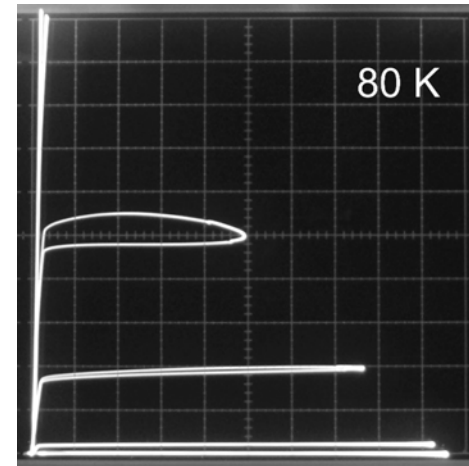
Transistors are the backbone of computer technology and power systems. These silicon-germanium (SiGe) HBTs are power-level devices capable of operating at cryogenic temperatures below liquid-nitrogen temperature (-196°C) to as low as $\sim 40\text{ K}$ (-230°C). In contrast, conventional silicon-based bipolar transistors cannot operate effectively at cryogenic temperatures.

COMMERCIAL APPLICATIONS

- ◆ Medical electronics, such as Magnetic Resonance Imaging (MRI) equipment.
- ◆ Shipboard power management.
- ◆ Electric power transmission and distribution.
- ◆ Superconducting Magnetic Energy Storage (SMES).
- ◆ Magnetic confinement systems for fusion power.

SOCIAL / ECONOMIC BENEFITS

- ◆ Use of cryogenics and silicon-germanium HBTs can enable greater efficiency of energy usage.



Left: characteristics of a SiGe HBT operating at a temperature of 80 K (-196°C); vert. 10 A full scale, horiz. 20 V full scale.
Right: photomicrograph of a 5-mm x 5-mm HBT die.

NASA APPLICATIONS

Space missions and space exploration, for example to the Moon and Mars, require electronics to function under extreme temperatures. Silicon-germanium HBTs can be used in power conversion and motor control applications at extremely low temperatures for NASA missions, reducing or eliminating the need for thermal control and reducing size and weight.